CLAIMS

Claim 1. A transmitting apparatus for transmitting a multi-carrier modulated signal having a plurality of sub-carriers modulated in response to transmission data, comprising:

a transmission path estimation method selection circuit for selecting an estimation method of the transmission path in response to an attribute of said transmission data,

a mapping circuit for arranging signal points in said plurality of sub-carriers in response to a selected modulation method based on said transmission data,

a transmission path estimation processing circuit for estimating a transmission path for the output signal of said mapping circuit in response to said selected transmission path estimation method, and

an orthogonal transform circuit for orthogonally transforming an output signal of said transmission path estimation processing circuit.

Claim 2. A transmitting apparatus as set forth in claim 1, wherein said transmission path estimation method selection circuit selects said transmission path estimation method in response to a size of said transmission data.

Claim 3. A transmitting apparatus as set forth in claim 1, wherein said transmission path estimation method selection circuit selects said transmission path estimation method in response to a perceived importance of said transmission data.

Claim 4. A transmitting apparatus as set forth in claim 1, wherein said transmission path estimation method selection circuit selects said transmission path estimation method in response to a state of a transmission channel.

Claim 5. A transmitting apparatus as set forth in claim 1, wherein said transmission path estimation method selection circuit selects said transmission path estimation method in response to a possibility of retransmission of said transmission data when said transmission fails.

Claim 6. A transmitting apparatus as set forth in claim 1, wherein said transmission path estimation method selection circuit has a differential modulation circuit for differentially modulating the output signal of said mapping circuit.

Claim 7. A transmitting apparatus as set forth in claim 6, wherein said differential modulation circuit outputs a modulated signal in response to a phase difference between a transmission signal and a reference with an adjoining transmission signal on a time axis as the reference.

Claim 8. A transmitting apparatus as set forth in claim 6, wherein said differential modulation circuit outputs a modulated signal in accordance with a phase difference between a transmission signal and a reference with an adjoining transmission signal on a frequency axis as the reference.

Claim 9. A transmitting apparatus as set forth in claim 6, wherein said differential modulation circuit outputs a modulated signal in accordance with a phase difference between a transmission signal and a reference with an adjoining transmission signal on a time axis and frequency axis as the reference.

Claim 10. A transmitting apparatus as set forth in claim 1, wherein said transmission path estimation processing circuit has a pilot addition circuit adding a transmission path estimation pilot signal to a transmission signal output by said mapping circuit.

Claim 11. A transmitting apparatus as set forth in claim 10, wherein said pilot addition circuit adds said pilot signal to said transmission signal by a constant rate from the time of start of transmission.

Claim 12. A transmitting apparatus as set forth in claim 10, wherein said pilot addition circuit reduces the number of pilot signals to be added each modulation time after the start of transmission.

Claim 13. A transmitting apparatus as set forth in claim 10, wherein said pilot addition circuit holds a ratio of said pilot signals added to said transmission signal at a constant when a predetermined time elapses after a start of transmission.

Claim 14. A transmitting apparatus as set forth in claim 10, wherein said pilot addition circuit stops the adding of said pilot signal when a predetermined time elapses after a start of transmission.

Claim 15. A transmitting apparatus as set forth in claim 10, wherein said orthogonal transform circuit performs an inverse fast Fourier transform on an output signal of said transmission path estimation processing circuit.

Claim 16. A receiving apparatus for receiving a multi-carrier modulated signal to which a predetermined transmission path estimation is processed by a transmitting apparatus, comprising:

an orthogonal transform circuit for orthogonally transforming a received signal,

a transmission path estimation circuit for estimating a characteristic of a transmission path in response to a processing of an estimation of the transmission path carried out by said transmitting apparatus based on an output signal of said orthogonal transform circuit, and

a data output circuit for correcting said received signal in response to a result of the estimation of said transmission path estimation circuit and outputting the received data.

Claim 17. A receiving apparatus as set forth in claim 16, wherein said orthogonal transform circuit performs a fast Fourier transform on said received signal.

Claim 18. A receiving apparatus as set forth in claim 16, wherein said transmission path estimation circuit includes:

a differential demodulation circuit for differentially demodulating the output signal of said orthogonal transform circuit at a predetermined time as a reference signal when said transmitting apparatus performs the differential modulation, and

a transmission path equalization circuit for extracting a pilot signal from the output signal of said orthogonal transform circuit when adding the pilot signal to the transmission data by said transmitting apparatus and estimating characteristics of the transmission path in response to the extracted pilot signal.

Claim 19. A receiving apparatus as set forth in claim 18, wherein said differential demodulation circuit has:

a storage circuit for storing the output signal of said orthogonal transform circuit, and

a phase correction circuit for correcting a phase of the output signal of said orthogonal transform circuit with a predetermined storage signal among said stored signals as the reference in response to the modulation method of differential modulation in the transmitting apparatus.

Claim 20. A receiving apparatus as set forth in claim 16, wherein said transmission path equalization circuit includes:

a pilot extraction circuit for extracting a pilot signal from the output signal of said orthogonal transform circuit,

a first addition circuit, in a case where said extracted pilot signal is divided into groups established in accordance with the frequency bands, for adding pilot signals of each group with at least one pilot signal from an adjoining group,

a multiplication circuit for multiplying a result of addition of the pilot signals at an adjoining previous modulation time on the time axis by a predetermined coefficient, and

a second addition circuit for adding a result of addition of the first addition circuit at a present point of time and an output signal of said multiplication circuit.

Claim 21. A receiving apparatus as set forth in claim 16, wherein said data output circuit outputs the received data of a predetermined number of bits based on said received signal in accordance with the modulation method of the received signal.

Claim 22. A communication system for transmitting and receiving a multi-carrier modulated signal created in accordance with the transmission data, comprising:

a transmission path estimation method selection circuit for selecting a transmission path estimation method in accordance with an attribute of said transmission data,

a mapping circuit for arranging signal points based on said transmission data by modulation methods set with respect to a plurality of sub-carriers,

a transmission path estimation processing circuit for signal processing for estimating the transmission path in accordance with said selected transmission path estimation method for an output signal of said mapping circuit,

a first orthogonal transform circuit for orthogonally transforming an output signal of said transmission path estimation processing circuit,

a transmission circuit for transmitting an output signal of said first orthogonal transform circuit to the transmission path,

a reception circuit for receiving a transmission signal from said transmission path,

a second orthogonal transform circuit for orthogonally transforming an output signal of said reception circuit,

a transmission path estimation circuit for estimating a characteristic of the transmission path based on processing of an estimation of the transmission path carried out by said transmission path estimation processing circuit based on the output signal of said second orthogonal transform circuit, and

a data output circuit for correcting said signal received by said reception circuit in accordance with the result of the estimation of said transmission path estimation circuit and outputting the predetermined received data.

Claim 23. A communication system as set forth in claim 22, wherein said transmission path estimation method selection circuit selects said transmission path estimation method in accordance with a size of said transmission data.

Claim 24. A communication system as set forth in claim 22, wherein said transmission path estimation method selection circuit selects said transmission path estimation method in accordance with a perceived importance of said transmission data.

Claim 25. A communication system as set forth in claim 22, wherein said transmission path estimation method selection circuit selects said transmission path estimation method in accordance with a state of a transmission channel.

Claim 26. A communication system as set forth in claim 22, wherein said transmission path estimation method selection circuit selects said transmission path estimation method in accordance with a possibility of retransmission of said transmission data when said transmission fails.

Claim 27. A communication system as set forth in claim 22, wherein said transmission path estimation method selection circuit has a differential modulation circuit for differentially modulating an output signal of said mapping circuit.

Claim 28. A communication system as set forth in claim 27, wherein said differential modulation circuit outputs a modulated signal in accordance with a phase difference between a transmission signal and a reference with an adjoining transmission signal on a time axis as a reference.

Claim 29. A communication system as set forth in claim 27, wherein said differential modulation circuit outputs a modulated signal in accordance with a phase difference between a transmission signal and a reference with an adjoining transmission signal on a frequency axis as a reference.

Claim 30. A communication system as set forth in claim 27, wherein said differential modulation circuit outputs a modulated signal in accordance with a phase difference between a transmission signal and a reference with an adjoining transmission signal on a time axis and frequency axis as a reference.

Claim 31. A communication system as set forth in claim 22, wherein said transmission path estimation processing circuit has a pilot addition circuit adding a transmission path estimation pilot signal to a transmission signal output by said mapping

circuit.

Claim 32. A communication system as set forth in claim 31, wherein said pilot addition circuit adds said pilot signal to said transmission signal at a constant rate from a time of starting transmission.

Claim 33. A communication system as set forth in claim 31, wherein said pilot addition circuit reduces the number of pilot signals to be added each modulation time after a start of transmission.

Claim 34. A communication system as set forth in claim 31, wherein said pilot addition circuit holds a ratio of said pilot signals added to said transmission signal at a constant when a predetermined time elapses after a start of transmission.

Claim 35. A communication system as set forth in claim 31, wherein said pilot addition circuit stops the adding of said pilot signal when a predetermined time elapses after a start of transmission.

Claim 36. A communication system as set forth in claim 22, wherein said orthogonal transform circuit performs an inverse fast Fourier transform on an output signal of said transmission path estimation processing circuit.

Claim 37. A communication system as set forth in claim 22, wherein said second orthogonal transform circuit performs a fast Fourier transform on said received signal.

Claim 38. A communication system as set forth in claim 22, wherein said transmission path estimation circuit includes:

a differential demodulation circuit for differentially demodulating the output signal of said second orthogonal transform circuit with the output signal of said orthogonal transform circuit at a predetermined time as a reference signal when said transmitting apparatus is engaged in differential modulation, and

a transmission path equalization circuit for extracting a pilot signal from the output signal of said second orthogonal transform circuit when adding the pilot signal to the transmission data by said transmitting apparatus and estimating characteristics of the transmission path in accordance with the extracted pilot signal.

Claim 39. A communication system as set forth in claim 38, wherein said differential demodulation circuit includes:

a storage circuit for storing the output signal of said orthogonal transform circuit, and

a phase correction circuit for correcting a phase of the output signal of said second orthogonal transform circuit with a predetermined storage signal in said stored signal as the reference in accordance with a modulation method of differential modulation in the transmitting apparatus.

Claim 40. A communication system as set forth in claim 38, wherein said transmission path equalization circuit includes:

a pilot extraction circuit for extracting said pilot signal from the output signal of said second orthogonal transform circuit,

a first addition circuit, in a case where said extracted pilot signal is divided into groups established in accordance with frequency bands, for adding pilot signals of each group with at least one pilot signal from an adjoining group,

a multiplication circuit for multiplying a result of addition of pilot signals at an adjoining previous modulation time on the time axis by a predetermined coefficient, and

a second addition circuit for adding a result of addition of the addition circuit at a present point of time and an output signal of said multiplication circuit.

Claim 41. A communication system as set forth in claim 22, wherein said data output circuit outputs the received data of a predetermined number of bits based on said received signal in accordance with a modulation method of the received signal.

Claim 42. A transmission method for transmitting a multi-carrier modulated signal having a plurality of sub-carriers modulated in accordance with transmission data,

comprising the steps of:

selecting a transmission path estimation method in accordance with an attribute of said transmission data,

performing mapping for arranging signal points in each said sub-carrier in accordance with the set modulation method, based on said transmission data,

performing signal processing on the mapped transmission for the estimation of the transmission path in accordance with said selected transmission path estimation method, and

orthogonally transforming said transmission data to which said transmission path estimation is processed.

Claim 43. A transmission method as set forth in claim 42, further comprising the step of selecting said transmission path estimation method in accordance with a size or a perceived importance of said transmission data.

Claim 44. A transmission method as set forth in claim 42, further comprising the step of selecting said transmission path estimation method in accordance with a state of a transmission channel.

Claim 45. A transmission method as set forth in claim 42, further comprising the step of selecting said transmission path estimation method in accordance with a possibility of retransmission of said transmission data when said transmission fails.

Claim 46. A transmission method as set forth in claim 42, further comprising the step of setting said modulation method in accordance with a characteristic of said transmission data.

Claim 47. A transmission method as set forth in claim 42, wherein said transmission path estimation method comprises a method of differential modulation in accordance with a phase difference between said transmission data and a reference.

Claim 48. A transmission method as set forth in claim 47, wherein said reference comprises an adjoining transmission data on a time axis.

Claim 49. A transmission method as set forth in claim 47, wherein said reference comprises an adjoining transmission data on a frequency axis.

Claim 50. A transmission method as set forth in claim 47, wherein said reference comprises an adjoining transmission data on either a time axis or a frequency axis.

Claim 51. A transmission method as set forth in claim 42, wherein said transmission path estimation method comprises a method of adding a transmission path estimation pilot signal to said mapped transmission data with a constant ratio and estimating the characteristic of the transmission path in accordance with the received pilot signal on the reception side.

Claim 52. A transmission method as set forth in claim 51, wherein the number of pilot signals added is reduced with each modulation time after a start of transmission.

Claim 53. A reception method for receiving a multi-carrier modulated signal to which a predetermined transmission path estimation is processed by a transmitting apparatus, comprising the steps of:

orthogonally transforming a received signal,

performing transmission path estimation processing based on said orthogonally transformed received signal,

correcting said received signal in accordance with a result of said estimation of a transmission path, and

outputting the received signal.

Claim 54. A receiving method as set forth in claim 53, wherein when the transmission path estimation processing is carried out by differential modulation by the transmitting apparatus, the received signal is stored and the received signal received later is differentially demodulated using a stored received signal as a reference.

Claim 55. A receiving method as set forth in claim 53, wherein when a pilot signal is added to the transmission signal by the transmitting apparatus, said pilot signal is extracted from among a received signals, characteristics of the transmission path are estimated in accordance with the extracted pilot signal, and a phase and an amplitude of the received signal are corrected in accordance with the result of estimation.

Claim 56. A communication method for transmitting and receiving a multi-carrier modulated signal produced in accordance with transmission data, comprising the steps of:

selecting a transmission path estimation method in accordance with an attribute of said transmission data,

performing mapping for arranging signal points based on said transmission data by a selected modulation method with respect to a plurality of sub-carriers,

performing signal processing on said mapped transmission data for estimating the transmission path in accordance with said selected transmission path estimation method,

orthogonally transforming the signal to which said transmission path estimation is processed,

transmitting said orthogonally transformed signal over the transmission path,

receiving the transmission signal from said transmission path as a received signal,

orthogonally transforming said received signal,

estimating characteristics of said transmission path based on said orthogonally transformed signal,

correcting said received signal in accordance with a result of said estimation of transmission path, and

outputting the received data.

Claim 57. A communication method as set forth in claim 56, further comprising the step of selecting said modulation method in accordance with a characteristic of said transmission data.

Claim 58. A communication method as set forth in claim 56, wherein said transmission path estimation method comprises a method of differential modulation in

accordance with a phase difference between said transmission data and a reference.

Claim 59. A communication method as set forth in claim 58, wherein said reference comprises an adjoining transmission data on a time axis.

Claim 60. A communication method as set forth in claim 58, wherein said reference comprises an adjoining transmission data on a frequency axis.

Claim 61. A communication method as set forth in claim 58, wherein said reference comprises an adjoining transmission data on one of a time axis and a frequency axis.

Claim 62. A communication method as set forth in claim 56, wherein said transmission path estimation method comprises a method of adding a transmission path estimation pilot signal to said mapped transmission data with a constant ratio and estimating the characteristic of the transmission path in accordance with a received pilot signal on the reception side.

Claim 63. A communication method as set forth in claim 62, wherein the number of pilot signals added is reduced with each modulation time after the start of transmission.

Claim 64. A communication method as set forth in claim 56, wherein when the transmission path estimation processing is carried out by differential modulation at a transmitting side, and the received signal is stored and the received signal received later is differentially demodulated using a stored received signal as a reference.

Claim 65. A communication method as set forth in claim 56, wherein when a pilot signal is added to the transmission signal at the transmitting side, said pilot signal is extracted from among the received signal, the characteristics of the transmission path are estimated in accordance with the extracted pilot signal, and the phase and the amplitude of the received signal are corrected in accordance with the result of estimation.